

CHAPTER IV

REPORTS OF MEETINGS OF COMMISSIONS

COMMISSION 4: ÉPHEMÉRIDES (EPHEMERIDES)

Report of Meeting 1985 November 21

PRESIDENT: T Lederle

SECRETARIES: H Schwan  
B D Yallop

1. Organization and Membership

The President's proposals for the Officers of the Commission for the next three years were adopted as follows:

President: B L Morando

Vice-President: P K Seidelmann

Organizing Committee: V K Abalakin, S Aoki, J Chapront, R L Duncombe, T Lederle, J H Lieske, B D Yallop, A Yamazaki

New Members of the Commission: J-E Arlot, V A Brumberg, N Capitaine, M Catalan, A de Castro, X-h Di, J O Dickey, A M Fominov, M Garcia de Polavieja, M L Gi, H L Hyok, M Iliyas, G A Krasinsky, Y Kubo, B-l Liu, M P Romero Perez, G Rosselo, J L Simon, D-zh Xian, X-z Zhao

Consultants: H-J Felber, X X Newhall, K G Steinert

2. Reports of the Commissions for 1983 to 1985

The President pointed out a correction in the report of the Commission in Trans. IAU 19A: line 8 on page 5 should read "the ratio of the mean solar day to the mean sidereal day". The President stated that he had asked for reports from the ephemeris offices, but the changes in the Almanacs would be discussed at the meeting of the Commissions on Tuesday, November 26.

3. Resolutions

At the Joint Discussion on Reference Systems on Wednesday, November 20, which was sponsored by Commissions 4, 7, 8, 19, 20, 24, 31, 33 and 40, two resolutions were adopted, one on astronomical constants, the other on reference systems. The Chairman of the Joint Discussion, J A Hughes, had referred these two resolutions back to the individual Commissions to obtain their separate approval since not enough time had been available for a full discussion at the Joint Discussion. After considerable discussion it was decided that the resolution on astronomical constants would be acceptable to Commission 4 if the words "physical and geophysical" were replaced by "geodetic", if the word "publish" was replaced by "provide for information purposes" and if the rider "5. to submit a preliminary report in 1987" was added at the end of the resolution.

There was also a long discussion on the resolution on reference systems. There was general agreement that item 4 in the resolution, which dealt with the organizational structure instead of the scientific aim should be deleted.

In addition P K Seidelmann commented that it would be appropriate if Commission 4 was given the responsibility for reference frames and he suggested

that the Presidents of the interested Commissions should consider the matter.

It was agreed that the President should draw these proposed changes to the attention of the Resolutions Committee.

#### Report of Meeting 1985 November 26

PRESIDENT: T Lederle

#### 1. The New Japanese Ephemeris

T Fukushima (Japanese Hydrographic Department) described the characteristics of the new Japanese Ephemeris which had been introduced in 1985. The main characteristics are that it uses the IAU 1976 system of astronomical constants, general relativity, a new planetary and lunar ephemeris and an "FK5-like" star catalogue. There are no apparent changes in the style of the published almanac except for the introduction of a rotation matrix to replace the Besselian day numbers.

The Einstein Infeld Hoffmann metric is used to derive the equations of motion which are applied to the Sun, Moon, eight major planets and four minor planets. The finite body interactions of the Sun, Earth and Moon and the effect of the Earth Moon tidal dissipation are also included in the new Japanese fundamental ephemeris (referred to here as JFE). In addition an analytical lunar libration theory has been used in the computations.

The initial conditions for the JFE are found by fitting over the period 1969 to 1981 the data from the JPL fundamental ephemeris DE118/LE62, which is equivalent to DE200/LE200 except that it is on the FK4 system, and the ephemeris of Duncombe for the minor planets.

The main difference between JFE and DE200/LE200 are that DE200/LE200 uses its own self-consistent set of planetary masses, it includes two more minor planets and it uses a numerical lunar libration theory. A comparison of JFE with DE200/LE200 shows differences of 1 mas or less. There were very small differences between the Japanese fundamental ephemeris (JFE) derived using the IAU 1976 planetary masses and JFE' derived the same way as JFE but using the DE200/LE200 planetary masses.

One conclusion that could be drawn was that the three new ephemerides published in the Japanese Ephemeris (JFE), the Astronomical Almanac (DE200/LE200) and the *Connaissance des Temps* (VSOP82/ELP-2000) are all equivalent to the precision printed.

The JFE has been extended to cover the period 1950 to 2050 and is available for export in machine readable form with software written in FORTRAN 77. The JFE has also been enlarged to include more planets and satellites and to contain physical information.

J O Dickey: Your comparison of the longitude of the Moon between JFE and DE200/LE200 shows a run-off at the ends which indicates that the wrong masses have been used.

P K Seidelmann: That type of characteristic could be obtained if libration were out of synchronization.

T Fukushima: We did synchronize lunar libration and in the comparison with JFE' the effect does not appear.

## 2. New developments with the JPL Ephemeris

J O Dickey (Jet Propulsion Laboratory) described the new developments at JPL on the DE125/LE125 ephemeris which is required for the Voyager 2 encounter with Uranus and the launch ephemeris for the Galileo mission to Jupiter. It is not intended as an export ephemeris. Other colleagues involved with the project but who are unable to be present are Standish, Williams, Newhall and Lieske. In addition to the observational data that were used to produce DE200/LE200 it incorporates new observations and a new integration. The new observations include transit circle observations from Herstmonceux and La Palma. Certain data were not included, but were used instead for verification. The optical navigation of Voyager demonstrates that it is dead on target.

T Lederle: JPL has the task and the need to compute the best possible ephemeris, but I am not sure that the ephemeris published in almanacs needs to be changed so frequently.

G A Wilkins: The published almanacs are consistent to the precision given.

T Lederle: The users are concerned at not knowing the basis of the ephemeris.

B Guinot: This matter will be considered by the new Working Group. The tendency is to impose too many rules on ephemeris producers when there should be more freedom.

S V Debarbat: We also need an ephemeris that we can use for long-term research, not one that lasts for three years.

The discussion turned to more general considerations about the publication of ephemerides and other information to meet the needs of observers. Wilkins raised the point that perhaps we had jumped to J2000.0 too soon and left others behind. Seidelmann suggested that the main problem was the lack of star catalogues for J2000.0. There were also problems with the transformation of star places from one equinox to another, and USNO would shortly produce a paper helping to solve this problem.

## 3. The Connaissance des Temps

B Morando discussed current ephemeris work at the Bureau des Longitudes. From 1984 onwards new ephemerides were introduced in the Connaissance des Temps. The Bureau is now working on analytical theories that are valid for long periods of time. Some of the results will be published shortly in Astronomy and Astrophysics. In particular the ephemerides have been used in climatic studies. New ephemerides of the satellite systems of Jupiter, Saturn and Uranus have been developed in a compressed form which combines Fourier series and Chebyshev polynomials. Ephemerides of minor planets brighter than magnitude 12 are available in machine readable form for observers who need them.

G A Wilkins: Sinclair and Taylor at the Royal Greenwich Observatory have done quite extensive work on the satellites of Saturn and more recently on those of Uranus.

## 4. The USSR Astronomical Yearbook

V Abalakin talked about the Yearbook which may be traced back to 1919 when it was a much smaller booklet. The basis of the 1986 volume changed with the introduction of the 1976 IAU system of astronomical constants and the use of DE200/LE200

which was supplied by JPL and USNO. The only noticeable change in appearance was the replacement of the Moon's hourly ephemeris with daily Chebyshev coefficients. He was grateful to Seidelmann, Lieske, Standish and Lederle for their help in introducing the changes. About 2,000 copies of the Yearbook are published and about 250 copies are distributed to other institutes. Explanations in English and in German are being produced. Numerical research into the libration of the Moon using Euler's coordinates is being undertaken at the Institute of Theoretical Astronomy.

#### 5. The Apparent Places of Fundamental Stars (APFS)

T Lederle reviewed the history of APFS. It was Sadler and Clemence who first conceived the idea of an international almanac with USNO, Washington and HMNAO, Herstmonceux responsible for the Sun, Moon and planets, ARI, Heidelberg for the stars and ITA, Leningrad for the minor planets.

At present APFS is based on the FK4. All other changes recommended by the IAU were introduced with the 1984 edition. The 1988 volume will be based on the FK5 and the corrections FK5-FK4 will be included for the years 1984 to 1987. The introduction will be rewritten, but perhaps some of the translations into other languages will disappear. Comrie first introduced the multi-language versions in 1940 and this may be a suitable time to break the tradition.

C A Smith: APFS is invaluable for checking computer software results and it was remarkable how many users were disclosed when the publication was late to appear in the USA.

A Bandyopadhyay: We have not been able to compute our own fundamental ephemeris. I would be glad to have the opportunity for some of my staff to be able to work at other ephemeris offices.

#### 6. Lunar Occultations

T Fukushima presented the first report of the International Lunar Occultation Centre (ILOC). The ILOC group now comes under the Maritime Safety Agency, Hydrographic Department, Geodesics and Geophysics Division. The Head of the Division is K Sugimoto. The ILOC will supply grazing predictions and limit line maps. Reduction was changed to the new reference system in 1985 but because of problems in convergence the (O-C)'s have not been returned to the observers yet. The number of observations has fallen from over 15000 in 1982 to just over 5000 in 1984 but the number of photoelectric observations has risen above 1000, mainly due to Japanese observers. A preliminary analysis of  $\Delta\lambda$  and  $\Delta\beta$  using the photoelectric observations shows a large systematic difference of between 0".2 and 0".5 in longitude and -0".17 and 0".25 in latitude. This could possibly be due to an error in Watt's charts which are fitted to the centre of figure and not the barycentre.

#### 7. Physical Ephemeris of the Sun

P K Seidelmann announced that Commission 10 had passed a resolution that Carrington's rotation elements for the Sun should be used. The Astronomical Almanac will return to using Carrington's values instead of those given by the working group on cartographic coordinates and the rotational elements of the planets.